April 10, 2009

Mr. Richard Boyle, Chief
Radioactive Materials Branch
Office of Hazardous Materials
Technology
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590

SUBJECT: 1860A APPLICATION – ACKNOWLEDGEMENT OF WITHDRAWAL

Dear Mr. Boyle:

This refers to your request dated March 21, 2008, for a recommendation concerning the revalidation of the Model No. 1860A Package, Australian Certificate of Approval No. AUS/2007-13/B(U)-96, Revision 0.

By email dated April 9, 2009, you requested to withdraw the application from NRC review. The NRC acknowledges your request to withdraw the application. NRC staff activities on the review have ceased and the associated Technical Assignment Control number has been closed.

Attached are specific shielding and thermal deficiencies noted by NRC staff, which should be resolved before resubmitting the application.

If you have any questions regarding this matter, you may contact me at (301) 492-3321.

Sincerely,

/RA/
Eric Benner, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-3082
TAC No. L24201

Enclosure: Package Deficiencies

cc: J. Chamberlin, Department of Energy
John J. Miller, International Isotopes, Inc.

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PACKAGE DEFICIENCIES
Docket No. 71-3082
Model No. 1860A Package
Australian Certificate of Approval No. AUS/2007-13/B(U)-96, Revision 0

1.0. SHIELDING DEFICIENCIES

The purpose of the shielding review is to ensure that the package design meets the radiation limits set forth in the IAEA's regulations for radioactive materials transportation, TS-R-1. The review included evaluation of the applicant's shielding calculations contained in the section of the Safety Analysis Report (SAR) titled "Detailed Design Calculations" as well as descriptions of the design and technical drawings contained both in the SAR and the Engineering Report. Staff notes that review of the package was not completed due to an unresolved concern regarding package performance under accident conditions; therefore, the following is a description of staff's review to date.

Package Shielding Design

The 1860A is designed for the transportation of special form radioactive materials. The allowable contents are limited to Cesium-137, Iridium-192, Radium-226, and Cobalt-60. The 1860A package has six different configurations, or package types, A – F. Shielding is provided by lead only (Package Type A) or lead and tungsten (Package Types B – F). The dimensions of the tungsten shield differ between each configuration. The maximum allowable capacity for each of the allowable contents is the same for all the package types, except the Cobalt-60 contents. The contents limits are described in Appendix 1, Section 1.3 and Appendix 2 to the approval certificate. All contents are specified as point sources, except for Package Type D Cobalt-60 sources, which may be point or pencil sources.

The technical drawings for the package are presented in the Engineering Report accompanying the application. The Engineering Report is an appendix to the SAR and is thus captured in the Certificate of Approval, Appendix 1 reference to the SAR for the package description. Therefore the technical drawings are captured as part of the Certificate of Approval. Staff reviewed the drawings and finds that they do not describe the package's complete shielding design. Staff notes that, based upon its review, the shielding design relies upon source drawers (which hold the sources) to provide shielding and to maintain the source position centered in the package, consistent with the shielding analyses. Technical drawings for the drawers that may be used in the package are not included in the SAR. Staff did find a couple figures in the SAR appendices that provide information regarding one form of source drawer. Staff considered these figures as well as the applicant's analyses and the technical drawings to determine the specifications that would be required in order for the package to meet the applicable dose rate limits for transport; in this case, the intent is to make shipments by non-exclusive use transport. Also, the applicant provided information regarding the source drawers in a supplement to the application; however, this information was limited to overall dimensions of two basic drawer designs. Materials information was not included, which would be needed to determine whether the package meets the radiation limits for non-exclusive use shipments.

The package consists of an attenuator case enclosing a source drawer tube and a steel crumple shield. The tube and attenuator case shell are stainless steel. Lead and tungsten, as

applicable, fill the attenuator case. While the crumple shield surface is considered the surface of the package, the shielding analyses do not take credit for the crumple shield material. Only the lead and tungsten, as applicable, of the attenuator case are considered in the analyses.

Package Evaluation

The applicant set the limits on the package contents such that the package may be transported as a non-exclusive use shipment. This means the transport index (TI) will be less than 10 and the dose rate will not exceed 2 mSv/hr at any point on the external surface of the package. The applicant performed hand calculations to demonstrate that the package meets this TI limit for all contents for all proposed package configurations. The applicant's calculations indicated that the allowable contents all resulted in TI values of about 6 or less. No surface dose rates were calculated; however, the applicant's TI calculations, which involve an intermediate calculation at 5 cm from the package surface, indicate the surface limit of 2 mSv/hr for non-exclusive use transportation will be met.

The applicant did not calculate dose rates for a package under hypothetical accident conditions (HAC). Instead, the applicant presents an argument that even with the crush shield completely collapsed, since the dose rates at the crumple shield surface are less than 2 mSv/hr (15 cm from the attenuator case's surface), the HAC dose rates at 1 m from the attenuator case's surface will be less than the HAC limit of 10 mSv/hr. This argument relies upon the source remaining securely in position and the attenuator case shielding being unaffected by the HAC tests. Staff reviewed the results of the package testing and found that, for the testing described in the SAR, the attenuator case will only experience minor damage that won't affect the attenuator shielding.

However, staff has a concern about the ability of the end cap to remain in place, and thus the source being maintained in its location within the package, under accident conditions, particularly for the 1-meter drop test onto a steel bar (TS-R-1 727(b)). The SAR needs to demonstrate that the end cap will not come off of the package (e.g., through shearing of the bolts) when impacted at any angle. While some angles pass through the crumple shield, the results of this test along the side of the package have shown that the bar will penetrate and impact on the attenuator case; thus, the bar may also penetrate the crumple shield at the package ends and impact on the end cap as well. Staff notes that TS-R-1 727(b) states that the bar for the test is to be 20 cm in length unless a longer bar would cause greater damage, necessitating the use of a bar of sufficient length to cause maximum damage. Therefore, the staff was unable to find that the package will meet the dose rate limits for accident conditions in Paragraph 657(b) since it has not been demonstrated that the package will retain the source and end cap in place under the test conditions described in this paragraph.

Staff Confirmatory Calculations

As part of its review, staff performed independent calculations using the MicroShield (V. 5) code. Models were developed using the drawings in the Engineering Report and the material descriptions in the SAR. Calculations were run for the allowable contents (as defined in the approval certificate) for the several package types. For all calculations, the source is assumed to be centered in the source drawer tube. Radial calculations indicated that the TI exceeds 10

for Co-60 in all but Package Type B. The TI also exceeds 10 for the Radium-226 (Ra-226) contents in all but Package Types B, C and D. In a supplement to the application, however, it was requested that Ra-226 not be considered for the revalidation. Therefore, further consideration of Ra-226 is not discussed and NRC recommends that the conditions of revalidation state that Ra-226 is not authorized. For calculations with MicroShield, staff used the outermost shield material with sufficient mean free paths as the buildup reference shield; this material was the lead. For the radial calculations, the source drawer was neglected. In all calculations the sources are taken to be point sources, with the pencils represented as distributions of point sources. Steel was represented as Iron (7.92 g/cc). The applicant indicated the Tungsten was 97% pure; therefore, Tungsten of 97% density (19.3 g/cc x 0.97 = 18.721 g/cc) was used by the staff.

Staff performed calculations for each package type for Co-60 contents for a variety of geometries to determine the location of the most limiting dose rate (or TI). These geometries included those at angles where the line of sight between the source and the detector misses the Tungsten shielding in the attenuator case. For pencil sources, this position is based upon the source point furthest from the case center (i.e., closest to the edge of the tungsten). Also, the TI for this off-radial geometry for Package Type D point sources was also calculated for all the package types, including for the pencil sources. Since package types E and F have square source tubes, the calculations for the radial as well as the other geometries were performed with the line of sight passing through the flat side of the tube as well as the corner of the tube. For these geometries that are not along the package's radial direction, assumptions regarding the source drawer were included for those cases where these geometries resulted in the limiting TI. For pencil sources, this included the assumption of 7.0 cm of Tungsten next to the source cavity (in the source drawer). Staff also assumed that the source drawer cavity was the same for all source pencils and was just long enough to fit the longest pencil described in the SAR shielding calculations; for shorter pencils, it is assumed that materials are used to keep the pencils centered in the drawer cavity though the materials used for that purpose are neglected in the calculations. The location of the most limiting TI is used to determine the contents limits for the different package types. The NRC recommends that the package be revalidated for the limits resulting from these calculations and described in Table 1 of this section. If the applicant desires to use the package for contents greater than those listed in the table, they will need to submit information, either appropriate calculations or actual measurements on the respective package types, to demonstrate the package will meet the dose limits for the desired transport method (in this case, non-exclusive use).

Staff also performed axial calculations that included a line of sight through the swipe test port (with the steel plug in place) and through the end cap and shine shield. These calculations were performed to determine the minimum amount of shielding and the shielding materials required for the source drawers to ensure the TI in the axial direction will remain less than 10. The axial calculations were performed with the TI location at one meter from the surface of the end cap. While the package design includes a crumple shield, the envelope of the crumple shield does not cover this area (an area 15 cm in diameter) on either end of the package. Thus, staff finds the package surface to be the end cap surface. The results of these calculations indicate the source drawers must meet the following conditions: 1) for point sources, the source cavity is no more than 4.0 cm in length; 2) for point sources in Package Types A, E and F, the source drawer must contain a minimum of 19.1 cm of lead on either side of the source cavity; 3)

for point sources in Package Types B, C and D, the drawer must contain a minimum of 21.2 cm of lead on either side of the source cavity; 4) the source drawer outer diameter should be 6.35 cm with a steel wall thickness of 0.3 cm; 5) for pencil sources, the drawer has 7.0 cm of tungsten on either side of the source cavity, which is 18.0 cm in length, followed by lead of at least 8.2 cm length; 6) the drawers must keep the sources centered in the package; and 7) the ends of the drawer have a 3.0-cm thick steel plug. As part of the calculations, the staff assumed the shielding portion of the source drawer is separated from the cavity by 0.5 cm of steel (treated as void in most of the calculations). The calculations also assume the source drawer is cylindrical for all sources. Regarding the tungsten in the source drawer for pencils, this condition is also derived from the off-radial TI calculations. Most of the axial calculations were performed with the contents limits specified in the approval certificate, with some calculations (particularly those with the pencil sources) using the new limits determined in the other calculations. Staff recommends the preceding specifications be included among the conditions for revalidation.

For the pencils, the calculation through the swipe test port plug resulted in a TI exceeding 10 for both the pencil represented by 3 points with 8.0 cm separation between points and the pencil represented by 7 points with 3.0 cm separation between points; therefore, the source strengths may need to be further reduced in order to meet the TI limit in Paragraph 526 and surface dose rate limit in Paragraph 531. Staff calculations indicated that the former pencil configuration resulted in a TI only slightly exceeding a TI of 10; therefore, considering that the effect of streaming will be diminished at distance from the package surface and the small size of the port geometry, the staff finds that the actual TI will more closely approach that determined for the geometry including the shine shield and end cap and the source strength determined by staff should be acceptable. The TI was significantly exceeded for the latter pencil configuration; therefore, staff further reduced the contents limits for this pencil configuration to an activity that resulted in a TI of approximately 10 for the geometry through the swipe port. This contents limit is shown in Table 1. Based upon the foregoing, the staff finds reasonable assurance that the package meets the radiation limits of TS-R-1 for the contents limits described with source drawers meeting the specifications used in the shielding analyses. As noted elsewhere, this finding is based upon the conditions described for recommending revalidation as well as resolution of outstanding staff concerns.

Package Operations

The staff also reviewed the operations descriptions for the 1860A package. The staff noticed an operation for determining the maximum contents at first use, particularly Item d on page 237 of the SAR under the heading “First Use, Maximum Activity Determination.” The operation indicates that a package may be used that cannot meet the radiation limits for the approved contents; it may be used by restricting that specific package’s contents to a capacity which can meet the radiation limits. The staff finds that this operation does not meet the requirement in Paragraph 501(b) of TS-R-1 regarding shielding effectiveness. The design analysis must show the package meets the radiation limits for the approved contents. A fabricated package must be shown to meet the requirements of the design (such as for shielding effectiveness). A package that cannot meet the radiation limits for the approved contents indicates that the shielding of the package does not meet the design requirement; therefore, the package is not useable.

Therefore, the staff recommends that the 1860A be revalidated with the condition that a package that cannot meet the radiation limits for the approved contents cannot be used.

Staff also did not see any operations descriptions regarding contamination surveys, surface dose rate measurements, removal/disabling of lift attachments, or, for empty packages, verification of the package being empty as part of pre-transport operations. These operations are required by TS-R-1 Paragraphs 502(a), 502(b), 508, 516, 520(c), and 531. Therefore, the staff recommends the 1860A be revalidated with the following condition that the pre-transport operations include the following:

1. external contamination surveys on loaded and unloaded/empty packages,
2. internal contamination surveys on empty packages that previously contained radioactive material,
3. surface dose rate measurements for loaded and unloaded/empty packages,
4. verification of an unloaded package being empty, and
5. removal/disabling of lift attachments for loaded and unloaded packages.

Table 1. Quantity Limits for 1860A[1,2,3]

Configuration (Package Type)	A	B	C	D	E	F
Co-60 Quantity TBq (Ci)	30 (810.8)	115 (3108)	330 (8919)	See note 1	25 (675.6)	42 (1135)

1. For Package Type D, the Co-60 source may be a point source or one of three varieties of pencil source. The limits for these in TBq (Ci) are as follows: point source – 330 (8919), pencil source distributed among 7 points – 175 TBq (4729), pencil source distributed among 3 points separated 8.0 cm – 180 (4864), pencil source distributed among 3 points separated 6.0 cm – 165 (4459).
2. The limits for Iridium-192 and Cesium-137 are the same as in the approval certificate.
3. Ra-226 is not an approved content under the revalidation; the applicant removed the Ra-226 from consideration in a supplement to the application.

Findings

Based upon a review of the application to date, the staff cannot make a final finding regarding a recommendation for revalidation of the 1860A package. This is due to the unresolved concern regarding the ability of the package to maintain the sources in the package (and in the package center) under accident conditions (as previously described). While there are statements recommending revalidation given the application of certain additional conditions, these statements are predicated upon the acceptable resolution of the foregoing concern.

Recommendations Summary

The following is a summary of those conditions which staff finds necessary to recommend revalidation, given favorable resolution of the concern regarding the package's performance under accident conditions. In any resubmittal addressing that concern, the applicant should also consider inclusion of analyses and/or information that address the concerns that are the basis for these recommendations.

1. The fabricated package must conform to the technical drawings described in the Engineering Report.
2. The source drawers must meet the following specifications:
    a. for point sources, the source cavity is no more than 4.0 cm in length;

   b. for point sources in Package Types A, E and F, the source drawer must contain a minimum of 19.1 cm of lead on either side of the source cavity;
   c. for point sources in Package Types B, C and D, the drawer must contain a minimum of 21.2 cm of lead on either side of the source cavity;
   d. the source drawer outer diameter should be 6.35 cm with a steel wall thickness of 0.3 cm;
   e. for pencil sources, the drawer has 7.0 cm of tungsten on either side of the source cavity, which is 18.0 cm in length, followed by lead of at least 8.2 cm length;
   f. the drawers must keep the sources centered in the package; and
   g. each end of the drawer has a 3.0-cm thick steel plug
3. Ra-226 is not an authorized content.
4. The limits for Co-60 are as specified in Table 1.
5. Fabricated packages that cannot meet the radiation limits for non-exclusive use for the allowed contents cannot be used.
6. Pre-transport operations include the following:
   a. external contamination surveys on loaded and unloaded/empty packages,
   b. internal contamination surveys on empty packages that previously contained radioactive material,
   c. surface dose rate measurements for loaded and unloaded/empty packages,
   d. verification of an unloaded package being empty, and
   e. removal/disabling of lift attachments for loaded and unloaded packages.

This information is needed to ensure compliance with Section VIII, Approval and Administrative Requirements, Regulation 807(d) of the IAEA Safety Standard Series, "The Regulations for the Safe Transport of Radioactive Material 1996 Edition (As Amended 2003), (TS-R-1).

2.0. THERMAL DEFICIENCIES

From a thermal standpoint, NRC staff found one major issue within the current SAR. The issue dealt with accounting for radiation on the package's fins and surface. Within this submittal, staff reviewed the thermal spreadsheet of the fin analysis provided and performed by the Australian Nuclear Science and Technology Organization (ANSTO). However, during the final submittal of additional information, it was unclear what values ANSTO used to calculate the fin's area and perimeter. These values are critical because they influence the corrected temperature distribution, shown in the latest submittal of additional information.

For future submissions, have the appropriate personnel available, in order to address issues mentioned by NRC staff. Within this previous submittal, NRC staff had an issue with the calculation of two key parameters within the package's fin analysis: its perimeter and area. If NRC staff would have had an opportunity to discuss the thermal analysis spreadsheet with ANSTO, staff may have been able to make a regulatory decision concerning the issue.

This information is needed to ensure compliance with Section VIII, Approval and Administrative Requirements, Regulation 807(d) of the IAEA Safety Standard Series, "The Regulations for the Safe Transport of Radioactive Material 1996 Edition (As Amended 2003), (TS-R-1).